

Hydrologic Issues Related to the Pebble Project, Alaska

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Outline

1. Physical Setting

- Surficial geology: Extent of low-permeability materials
- Permeability measurements
- Implications for mining impacts

2. Groundwater and Surface Water Hydrology

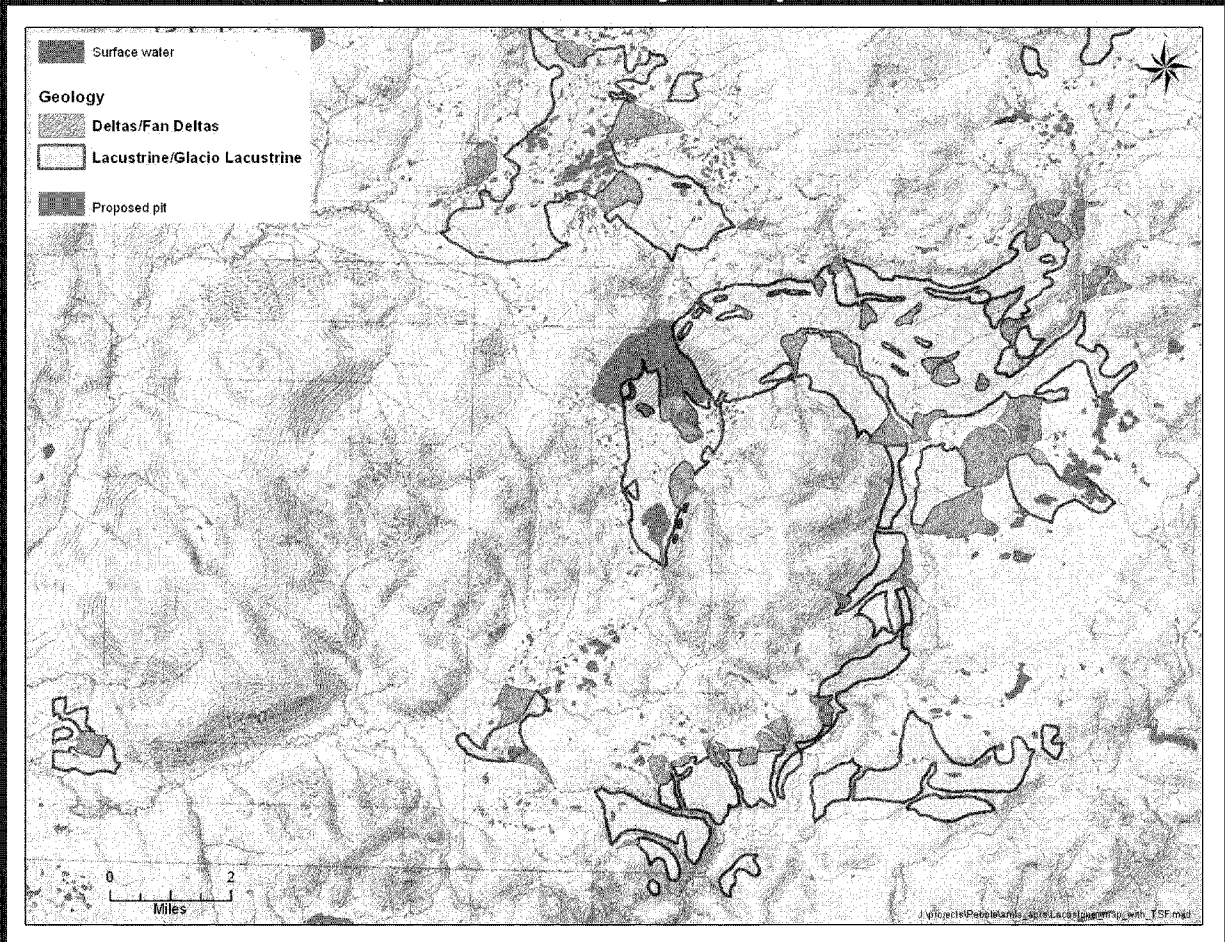
- Hydraulic gradients
- Surface water-groundwater interactions
- Interbasin transfers
- Implications for mining impacts

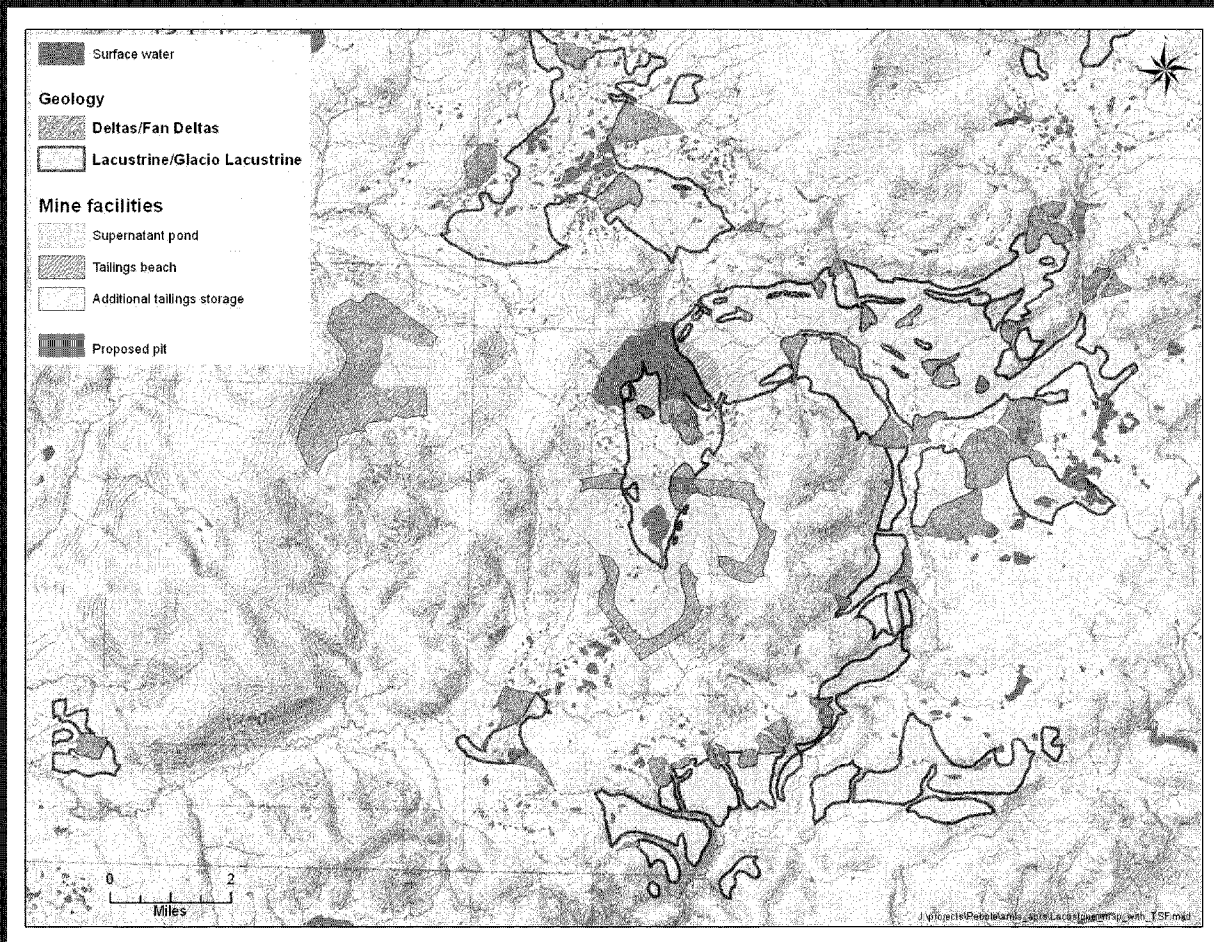
3. Ongoing Work

- Integrated surface water-groundwater modeling
- Coupled to atmospheric processes
- Evaluate pre-mine and post-mine conditions

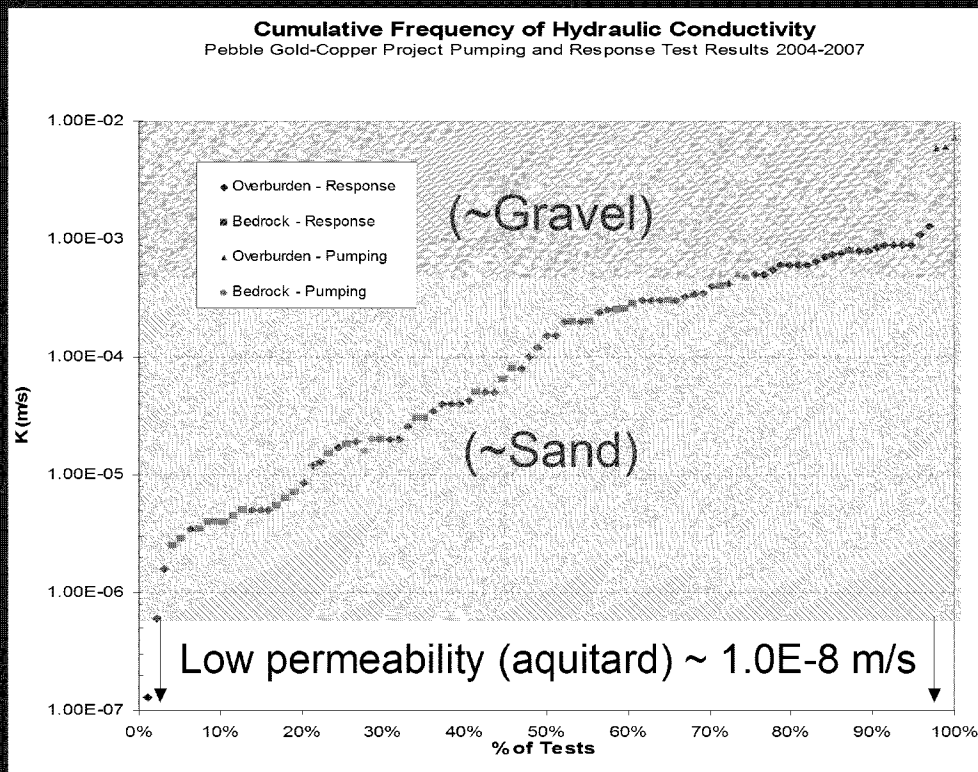
4. Summary

Extent of Low-permeability Deposits





Hydraulic Tests: Very High Permeabilities throughout Tested Materials



Smith and McCreddie, 2008

Physical Setting – Implications for Mining

- Limited extent of low-permeability materials at the surface
 - Surface impoundments will be leaky
- Very high permeability sand and gravel throughout mine area
 - Groundwater will flow quickly and freely

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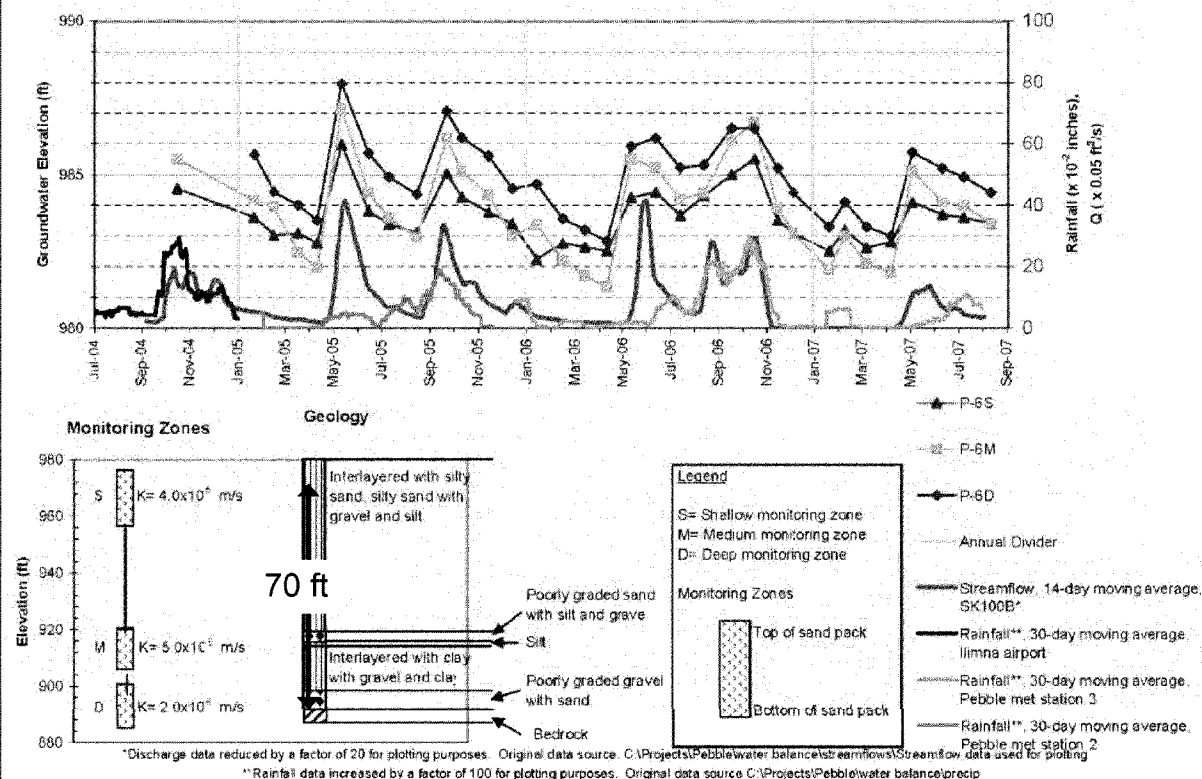
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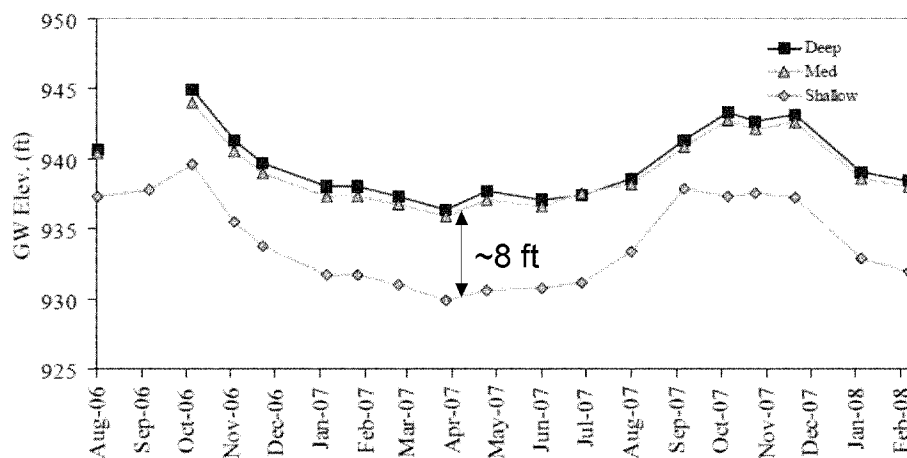
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Groundwater Elevation vs Time (P-6)



Shallow, medium, and deep groundwater respond together along with seasonal changes in streamflow near the pit. Moderate upward gradient.

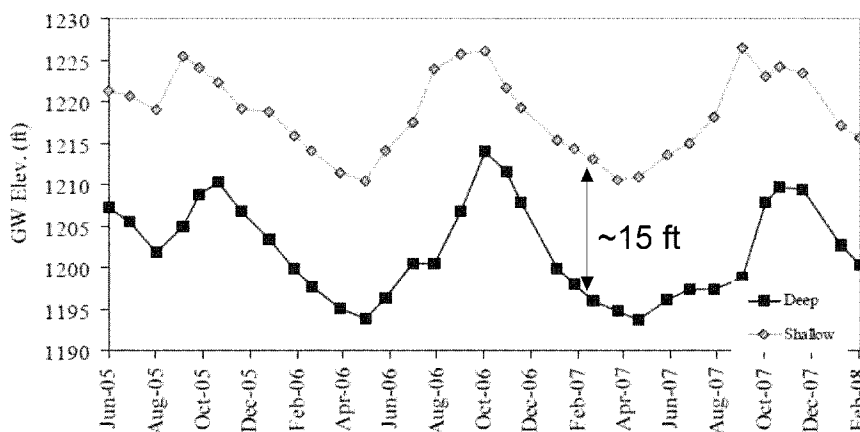
Well Cluster P-06-37



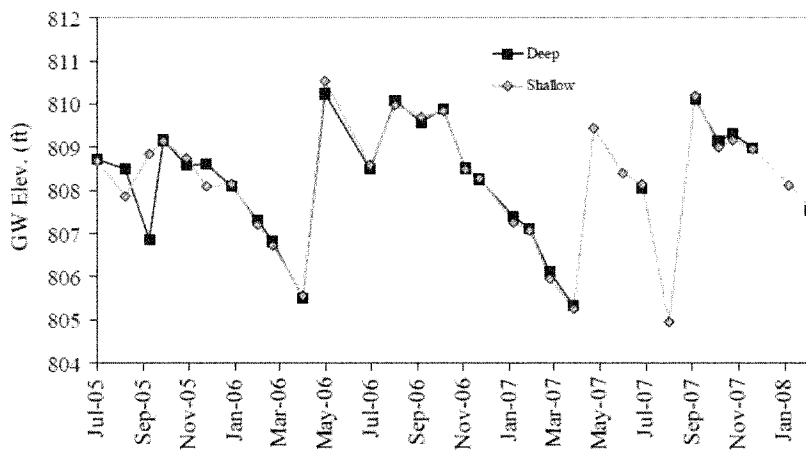
Upward Gradient
(deep GW > shallow GW)

Downward Gradient
(shallow GW > deep GW)

Well Cluster MW-05-12



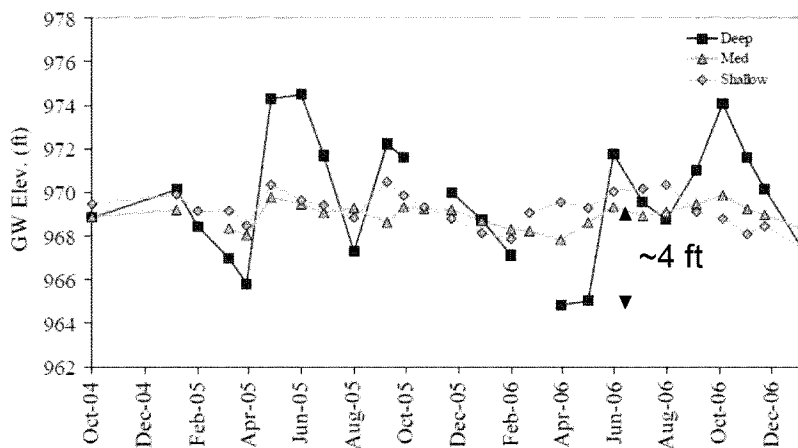
Well Cluster MW-05-13



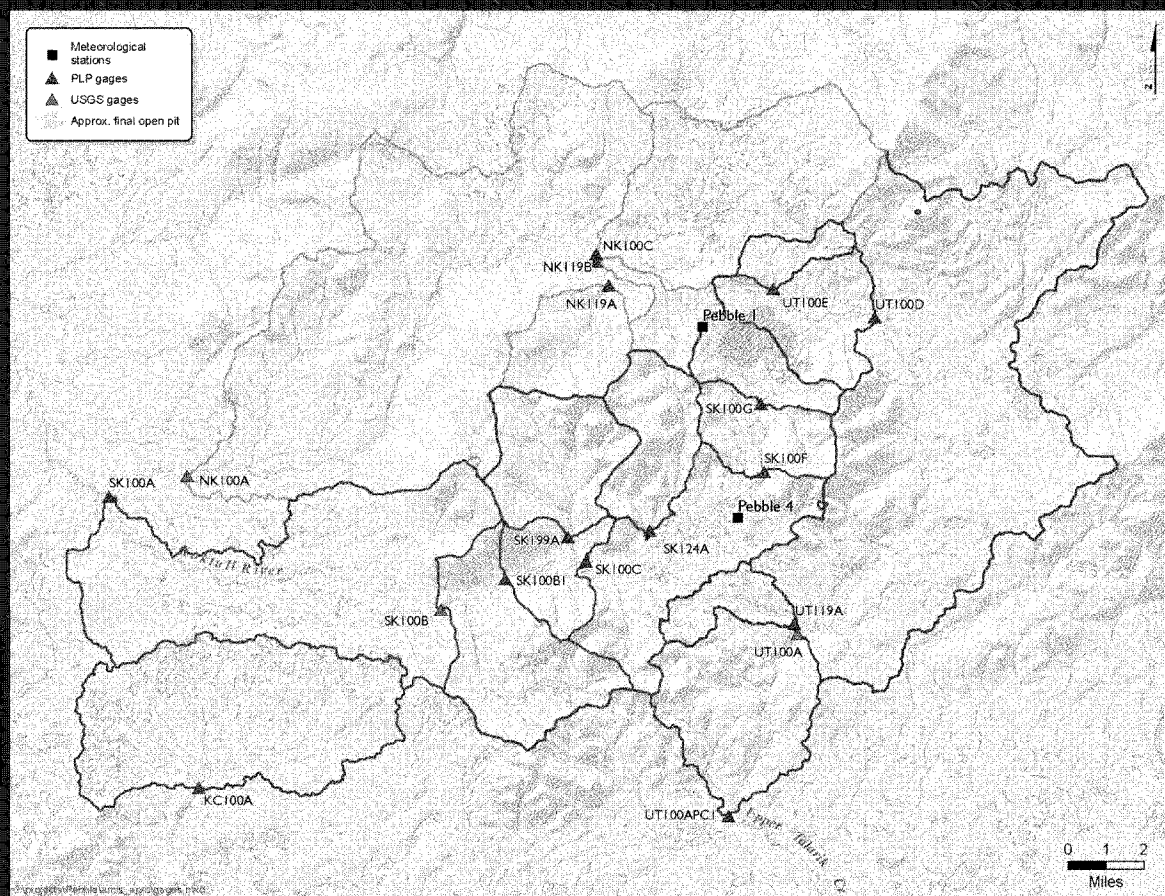
Negligible Gradient
(total communication between
shallow and deep GW)

Seasonally Variable Gradient
(aquifers are separated, but
deep GW is fed by surface)

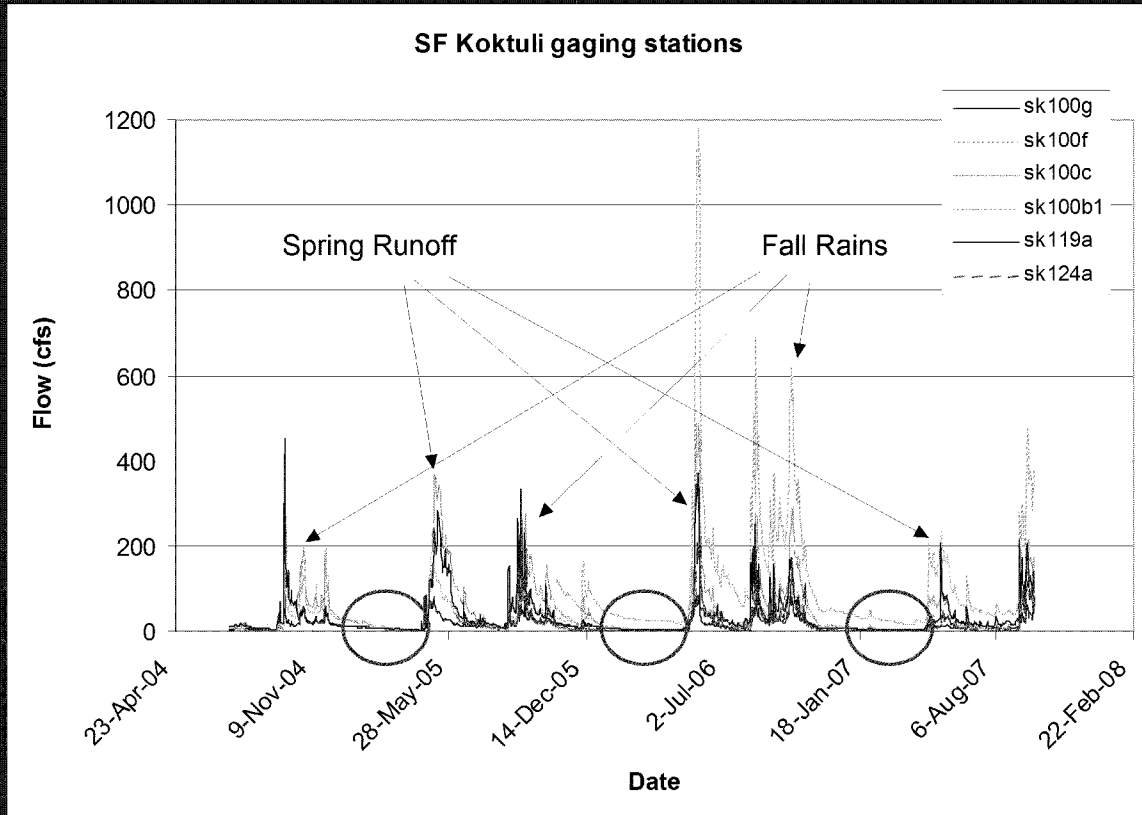
Well Cluster MW-5



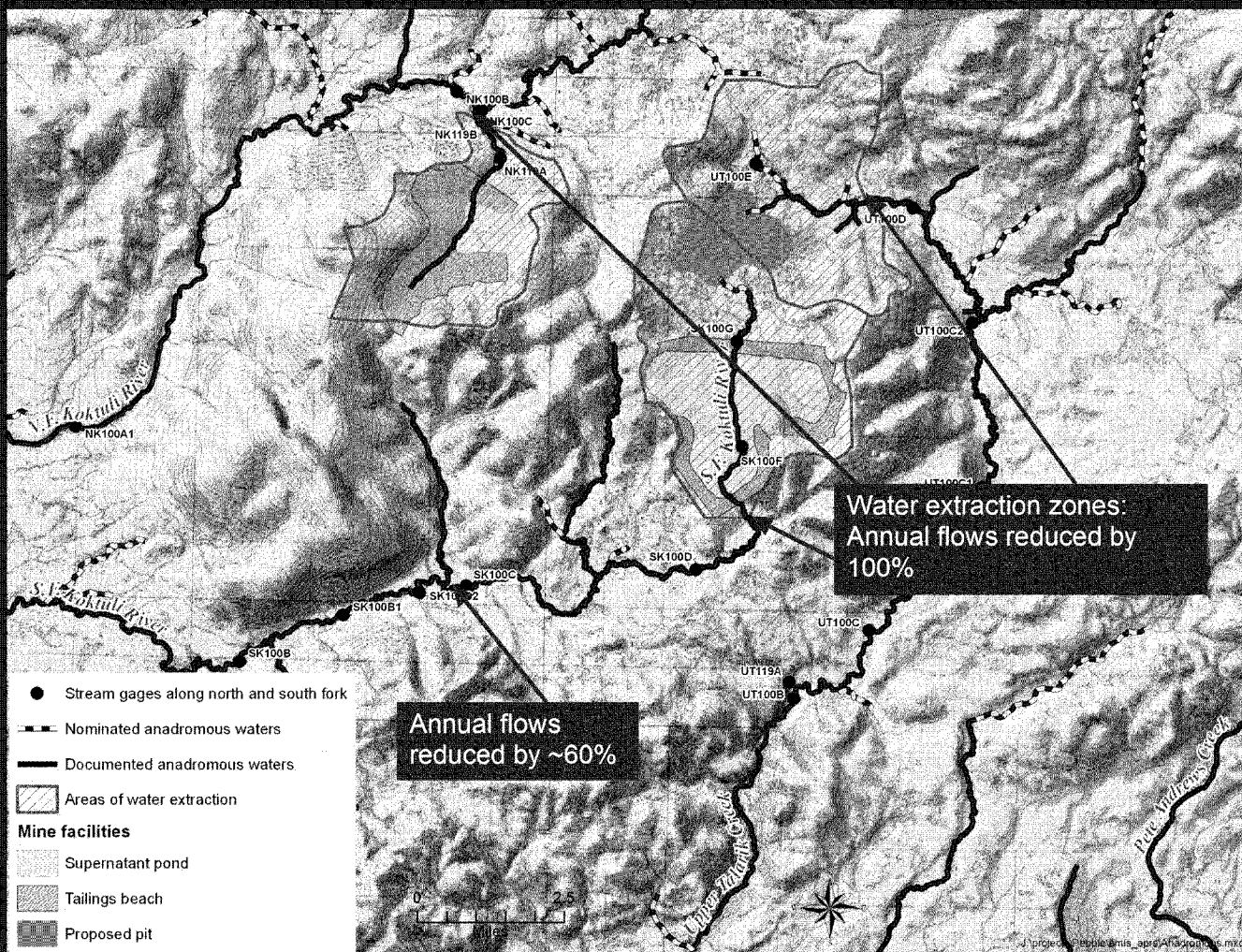
Stream Gages and Met Stations

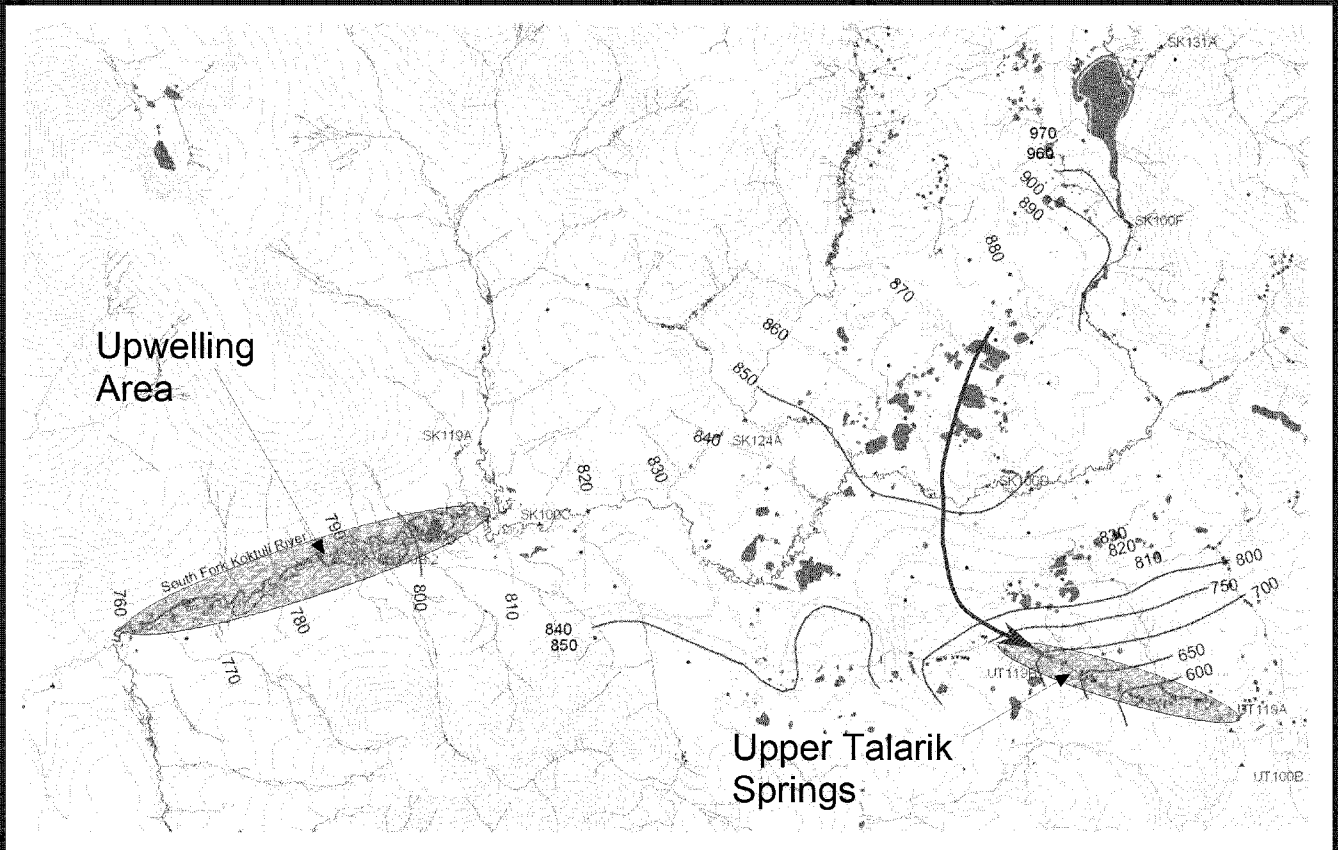


Streamflow Records: 2004–2007

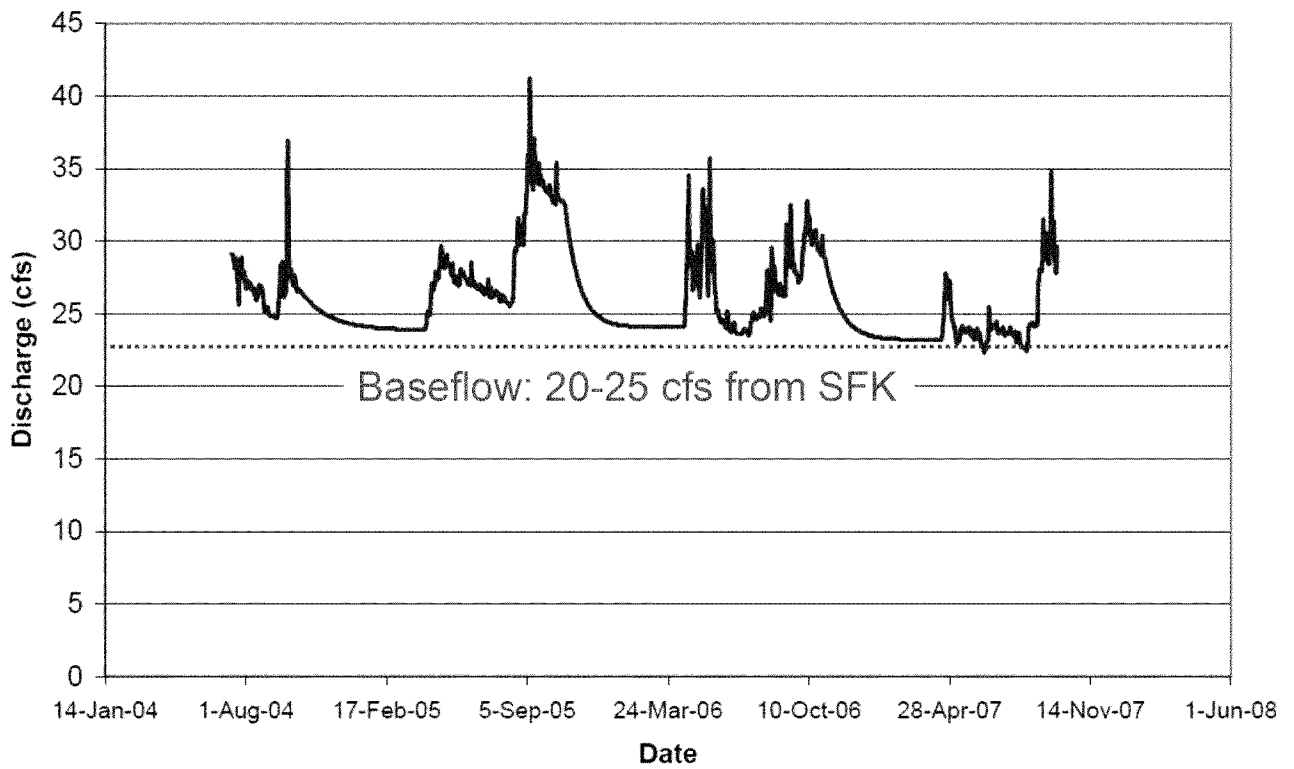


High seasonality to surface water flow, with very low (to zero) flows in late summer





UT 119A Hydrograph



Groundwater and Surface Water Hydrology: Implications for Mining

- Groundwater elevations vary seasonally
 - Water is flushed in and out of the ground seasonally
- Surface water flows are highly seasonal
 - Natural ability to dilute contamination varies through the year
- SF Koktuli loses ALL of its flow to groundwater and into the Upper Talarik in late summer
 - Contamination of SF Koktuli would also affect springs in Upper Talarik

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4. Summary

Ongoing Work – Motivation

- Available data indicate that surface water and groundwater are very closely linked at Pebble
- Models such as MODFLOW may not simulate coupled SW-GW interactions realistically
- Need to evaluate mine impacts in a fully coupled system

Ongoing Work – Goals

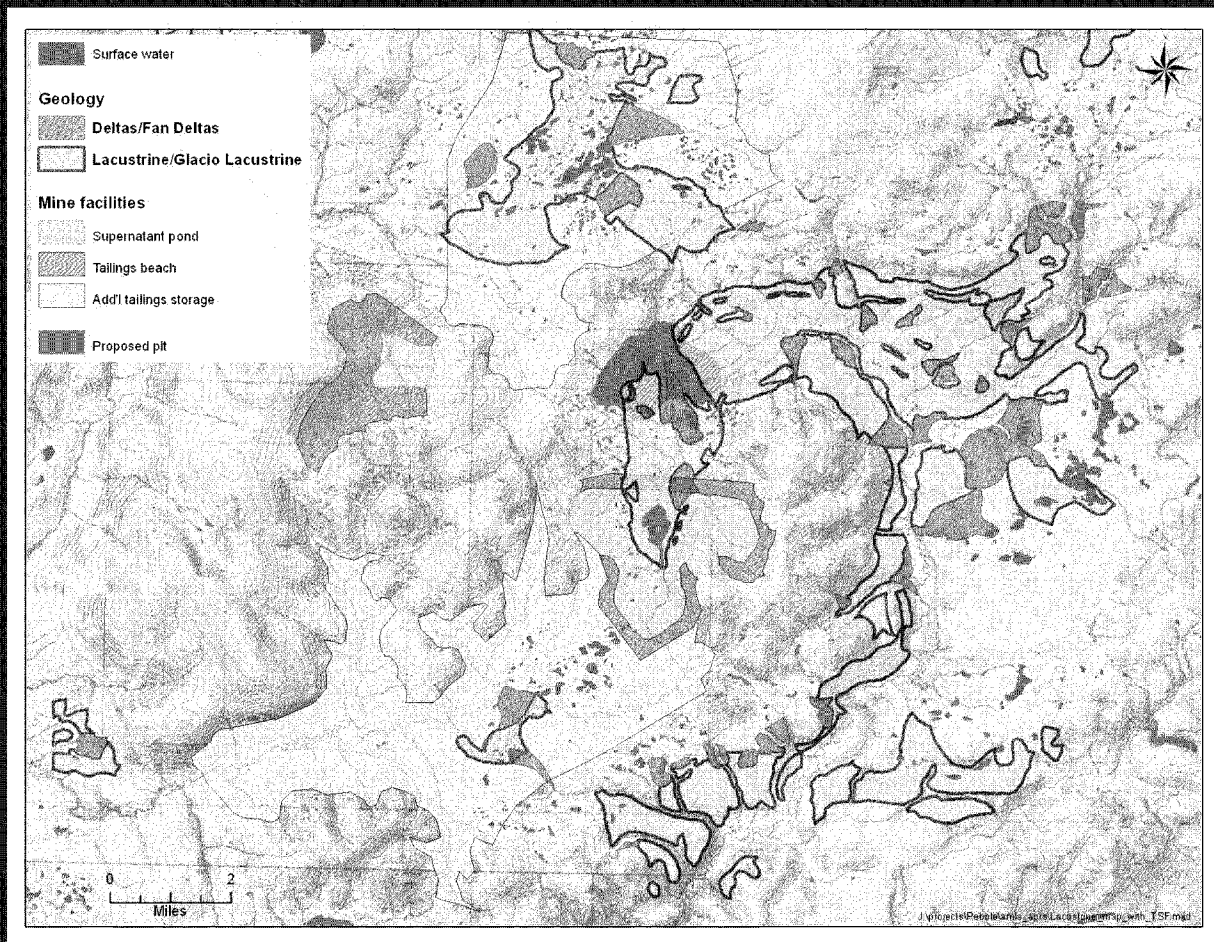
- Simulate fully coupled atmosphere-surface water-groundwater system under baseline conditions
 - Calibrate to observed GW and SW data
- Evaluate impacts of potential mining scenarios
 - Changes in hydrographs
 - Downstream changes in water quantity
 - Downstream changes in water quality due to mining

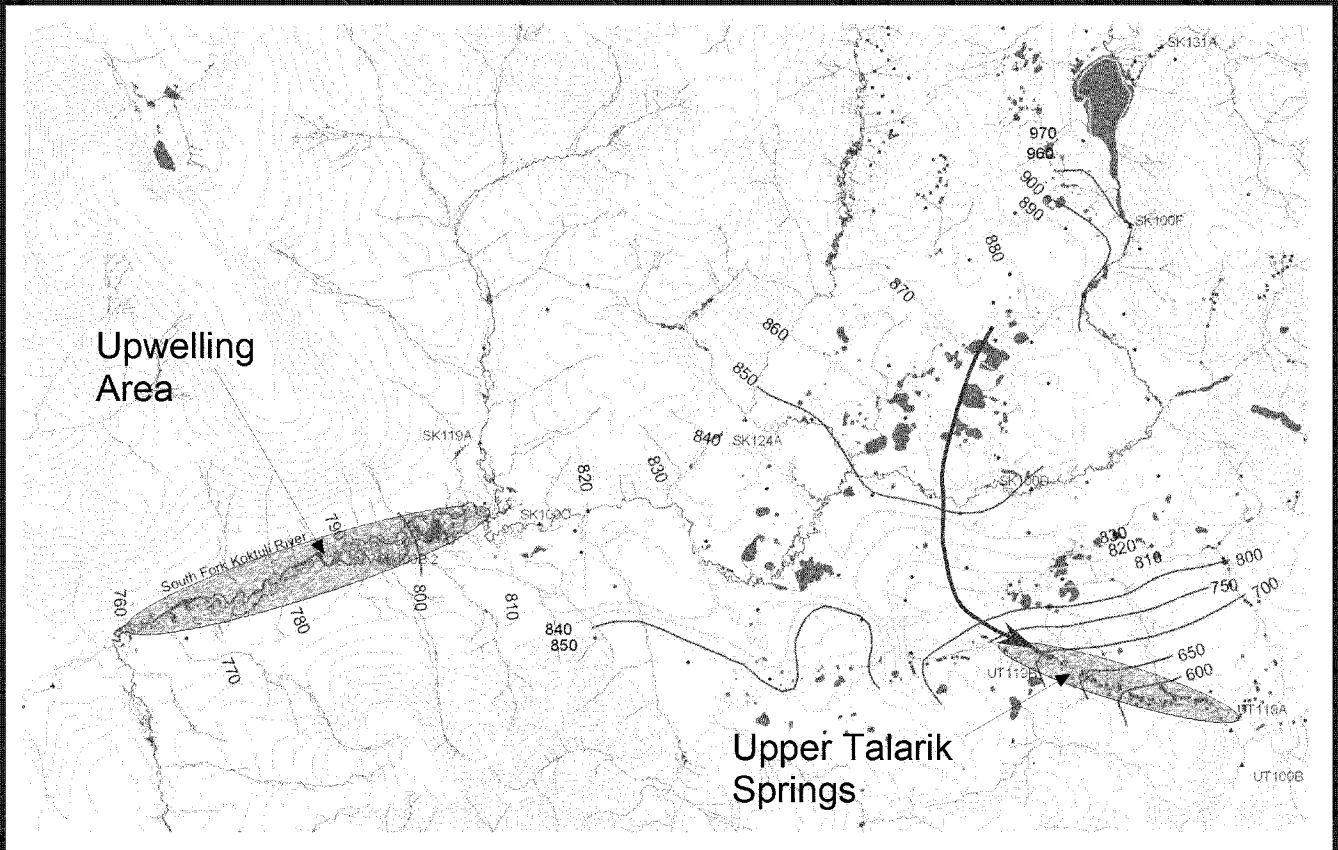
Hydrologic Model: DHI MikeSHE/Mike11

- ▣ Fully coupled GW-SW-Atmosphere model
- ▣ Inputs
 - Topography, stream network
 - Subsurface geology
 - Rainfall, ET, wind at 3-hour increments (NOAA NARR data)
- ▣ Outputs
 - Rainfall-runoff response and hydrographs
 - Groundwater elevations and storage

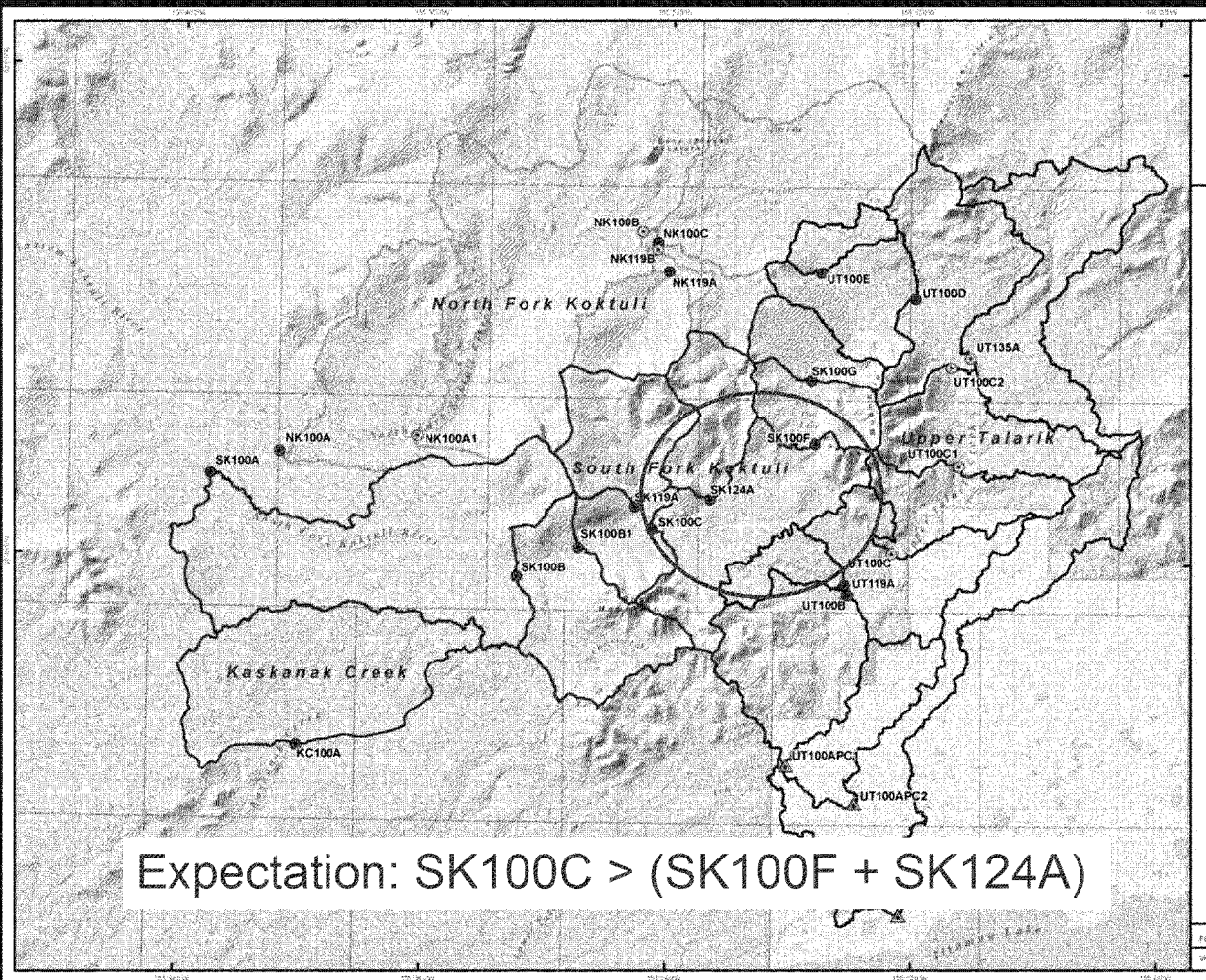
Summary

- Site geology is very “leaky”
 - Very few low permeability materials
 - Difficult to contain mining wastes
- Groundwater and surface water are closely coupled
 - Groundwater elevations and gradients change seasonally
 - Streams lose water to the ground that flows freely between basins
- Ongoing modeling study
 - Coupled atmosphere-surface water-groundwater model
 - Sub-daily timestep
 - Best chance of simulating potential mining impacts





Groundwater from SF Koktuli feeds Upper Talarik springs (Interbasin Transfer)



Expectation: SK100C > (SK100F + SK124A)

SFK Surface Flows are “Lost” between SK100F and SK100C

